

Amendments to the Claims:

1. – 65 (cancelled)

66. (original) A wavelength selective optical device, comprising  
a silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion; and  
a filter coupled to the superlattice.

67. (original) An optical switch, comprising:  
a silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion; and  
an optical waveguide.

68. (original) An optical device, comprising:  
a silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion;  
a silicon containing layer positioned on a surface of the superlattice; and  
at least one transistor positioned on a surface of the silicon containing layer.

69. (original) A nonlinear optical device comprising:  
a plurality of adjacent silicon based superlattice structures including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion;  
wherein each adjacent superlattice structure is grown in an alternating fashion to create a periodic variation in a refractive index

70. (original) A tunable laser system, comprising:  
first and second reflectors defining a resonator;  
a silicon based superlattice positioned between the first and second reflectors, the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth

ion; wherein the repeating units are periodic and a period of the repeating units is selected to produce a desired output wavelength.

a wavelength tuning member coupled to the laser;

a temperature sensor coupled to the laser; and

a control loop coupled to the temperature sensor and the tuning member, wherein in response to a detected change in temperature the control loop sends an adjustment signal to the tuning member and the tuning member adjusts a voltage or current supplied to the laser to provide a controlled output beam of selected wavelength.

71. (original) An optical receiver, comprising:

at least one p-doped layer;

at least one n- doped layer;

a silicon based superlattice positioned between the at least one p-doped layer and the at least one n-doped layer; the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion; and

at least two electrodes coupled to the at least one p-doped layer and the at least one n-doped layer of p-doped layer.

72. (original) The receiver of claim 71, wherein at least one p-doped layer and the at least one n- doped layer are made substantially of silicon.

73. (original) A semiconductor edge-emitting laser,

first and second reflectors defining a resonator;

a silicon based superlattice positioned between the first and second reflectors, the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion;

a confinement region that includes at least two electrodes.

74. (original) The laser of claim 73, further comprising:

cleaved or etched facets.

75. (original) The laser of claim 73, wherein the confinement region is positioned in a direction substantially parallel to an optical output direction of the laser.

76. (original) A laser assembly, comprising:  
first and second reflectors defining a laser resonator;  
a silicon based superlattice positioned between the first and second reflectors, the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion; wherein the repeating units are periodic, and a period and composition of the repeating units is selected to produce a desired output wavelength.

77. (original) The assembly of claim 76, wherein the first reflector is a distributed Bragg reflector.

78. (original) The assembly of claim 76, further comprising:  
an optical amplifier.

79. (original) A vertical cavity surface emitting semiconductor laser, comprising:  
first and second reflectors defining a resonator;  
a silicon based superlattice positioned between the first and second reflectors and confined to a substantially circular region whose diameter matches a single mode diameter of the laser, the silicon based superlattice including a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion and the repeating units are periodic, with a period and composition of the repeating units selected to produce a desired output wavelength.

80. (original) The laser of claim 79, wherein the first reflector is a distributed Bragg reflector.

81. (original) An optical switch, comprising:  
a first optical waveguide with biasing electrodes;  
a second optical waveguide with biasing electrodes, at least one of the first and second optical waveguides including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion;  
a coupling member that couples the first and second waveguides; and  
control circuitry coupled to the first and second waveguides.

82. (original) The switch of claim 81, further comprising:  
first and second outputs coupled to the first and second waveguides.

83. (original) The optical switch of claim 82, wherein the control circuitry is configured to selectively bias the first and second optical waveguides to switch optical signals to the first or second outputs.

84. (original) The optical switch of claim 81, wherein the coupling member couples the first and second waveguides to a third waveguide.

85. (original) The optical switch of claim 81, wherein the optical switch is a plurality of optical switches that form an N-to-N optical switch.

86. (original) A modulator, comprising:

a first optical waveguide with biasing electrodes;

a second optical waveguide with biasing electrodes, at least one of the first and second optical waveguides including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, the first and second waveguides having equal light paths;

a coupling member that couples the first and second waveguides;

at least one output coupled to the first and second waveguides; and

control circuitry coupled to the first and second waveguides to induce a refractive index change in one of the light paths and cause destructive interference between the light paths upon recombination of light at the output.

87. (original) An add/drop multiplexer, comprising:

a first waveguide;

a second waveguide;

a ring waveguide including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion; and

control circuitry coupled to ring waveguide, the control circuitry configured to couple light from the first waveguide to the ring waveguide and then to the second waveguide.

88. (original) An all optical N-to-N cross-connect comprising:

a first plurality of parallel waveguides;

a second plurality of planar parallel waveguides, positioned substantially orthogonal to the first plurality of waveguides;

a third plurality of curved waveguides positioned at overlap intersection points between the first and second pluralities of waveguides, each of a waveguide of the third plurality of curved waveguides including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion; and

control circuitry coupled to selectively bias gain or loss in the superlattices of the third plurality of curved waveguides to couple light from one of the first plurality of waveguides into one of the second plurality of waveguides.

89. (original) The cross-connect of claim 88, wherein at least a portion of the superlattice has a region that is optically active

90. (original) The cross-connect of claim 88, wherein at least a portion of the superlattice has a region that is electrically excitable to emit or absorb optical radiation.

91. (original) The cross-connect of claim 88, wherein at least a portion of the superlattice has a region that detects optical radiation.

92. (original) An optical wavelength converter, comprising:

a first optical waveguide;

a second optical waveguide, each of the first and second optical waveguides including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, superlattice including biasing electrodes to induce optical gain or loss within the first and second waveguides;

at least one coupling member coupling the first and second waveguides;

a first optical input signal and a second optical input signal coupled to the first and second optical waveguides; and

wherein the superlattices of the first and second optical waveguides are biased to provide gain for the first optical signal and transfer a modulation from the first optical input signal to the second optical input signal by at least one of cross-phase or cross-gain modulation.

93. (original) A dynamic gain equalizer, comprising:

an arrayed waveguide grating including at least two resonant cavities coupled by a plurality of curved waveguides, each of a waveguide including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, wherein lengths of the waveguides vary by a fraction of a wavelength of light propagating within the waveguides; and

control electronics to selectively bias each waveguide and produce a predetermined gain or loss to each wavelength in a spectrum of wavelengths exiting the arrayed waveguide grating.

94. (original) An integrated transponder, comprising:

a substrate;

at least one a p-doped layer and an n- doped layer

a silicon based superlattice including a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion and the superlattice is formed on the substrate; and electronic components integrated in the substrate and superlattice, the electronic components configured to provide at least one of control, filtering, clock recovery, signal detection, noise suppression and electronic signal processing of electrical signals generated by interaction between an optical input signal and superlattice and producing an optical output signal.

95. (original) A dynamic optical multiplexer/demultiplexer, comprising of:

a photonic band gap region forming dispersive member that spatially separates an input wavelength division multiplexed signal into a plurality of spatially separated individual wavelengths;

a plurality of outputs;

a plurality of waveguides coupled to the plurality of outputs, at least a portion of the plurality of waveguides having a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, the superlattice including electrical circuitry to selectively bias the superlattice for gain or loss;

a coupling device that combines the spatially separated waveguides into a single optical waveguide .

96. (original) A photonic integrated circuit, comprising:  
a plurality of waveguides, at least a portion of the plurality of waveguides having a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion;  
at least one optical switch;  
electronics coupled to the plurality of waveguides; and  
a substrate, wherein the plurality of waveguides, at least one optical switch and electronics are all integrated on the substrate.

97. (original) An optical intensity modulator, comprising:  
a plurality of waveguides, at least a portion of the plurality of waveguides having a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion; and  
electronics coupled to the plurality of waveguides, the electronics and plurality of waveguides being configured to modulate an input optical signal and produce a modulated output optical signal.

98. (original) An optical modulator, comprising:  
a plurality of waveguides, at least a portion of the plurality of waveguides having a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion; and  
electronics coupled to the plurality of waveguides, the electronics and plurality of waveguides being configured to vary at least one of refractive index and loss of the waveguide to modulate a phase of an input optical signal and produce a modulated output optical signal.

99. (original) The optical phase modulator of claim 98, wherein a second optical input signal directly modulates the output optical signal.

100. (original) An optical transistor comprising:  
a modulator, including  
a waveguide, at least a portion of the waveguide having a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion,  
electronics coupled to the waveguide, the electronics and waveguide being configured

to modulate an input optical signal and produce a modulated output optical signal, and  
an optical receiver coupled to the modulator, the optical receiver including,  
at least one p-doped layer,  
at least one n- doped layer,  
a silicon based superlattice positioned between the at least one p-doped layer and the  
at least one n-doped layer; the silicon based superlattice including a plurality of layers that  
form a plurality of repeating units, at least one of the layers being an active region layer with  
at least one rare earth ion, and  
at least two electrodes coupled to the at least one p-doped layer and the at least one n-  
doped layer of p-doped layer; wherein the receiver converts said optical signals received from  
the modulator into electrical signals and drives the modulator.

101. (original) The optical transistor of claim 100, further comprising:  
a clock recovery circuitry configured to retime and reshape optical pulses.

102. (original) The optical transistor of claim 101, further comprising:  
noise filtering circuitry configured to filter noise from the optical pulses input.

103. (original) The optical transistor of claim 101, further comprising:  
wherein a first optical input is a broad wavelength spectrum laser that produces a first  
optical input signal; and  
drive circuitry configured to select a laser wavelength and control wavelength  
conversion.

104. (original) An optical amplifier, comprising:  
a silicon based superlattice with a plurality of layers that form a plurality of repeating  
units, at least one of the layers being an active region layer with at least one rare earth ion;  
a semiconductor laser diode that produces an output signal with a wavelength in the  
range of 700 nm and 1700 nm; and  
a pump coupling that couples the semiconductor laser diode to the superlattice.

105. (original) A photonic device, comprising:  
a silicon based superlattice with a plurality of layers that form a plurality of repeating  
units, at least one of the layers being an active region layer with at least one rare earth ion,  
wherein at least a portion of the superlattice is made of substantially Group III-V or II-VI  
materials,



106. (original) A structure for efficient excitation or de-excitation mechanisms of crystal field engineered rare-earth silicon-based superlattice, comprising:  
a silicon semiconductor based superlattice that includes a plurality of layers that form a plurality of repeating units, at least one of the layers being an optically active layer with at least one species of rare earth ion;

a first layer of semiconductor materials, and

a second layer of semiconductor materials, wherein the superlattice is sandwiched between the first and second layers and the first and second layers each have a wider bandgap than the superlattice.

107. (original) An integrated transponder, comprising:

an optical receiver, including:

at least one p-doped layer and an n-doped layer;

a silicon based superlattice positioned between the at least one p-doped layer and the at least one n-doped layer; the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion; and

at least two electrodes coupled to the at least one p-doped layer and the at least one n-doped layer of p-doped layer

a laser coupled to the optical receiver, including,

first and second reflectors defining a resonator;

a silicon based superlattice positioned between the first and second reflectors, the silicon based superlattice including a plurality of layers that form a plurality of repeating units, wherein at least one of the layers is an active region layer with at least one rare earth ion;

electrical circuitry coupled to the laser and the optical receiver; and

electronics coupled to the laser and the optical receiver configured to provide at least one of control, filtering and clock recovery, signal detection, noise suppression and electronics signal processing of electrical signals generated by an interaction with an optical input signal and the superlattice of the laser.

108. (original) A silicon semiconductor based superlattice, comprising:

a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion,

wherein the superlattice forms a portion of a heterojunction bipolar transistor.

109. (original) A silicon semiconductor based superlattice, comprising:

a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, wherein at least a portion of the plurality of layers are interleaved with a plurality of quantum wells.

110. (original) An electrically pumped amplifier, comprising:

a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, wherein the layers are ultra-thin epitaxial layers.

111. (original) An optically pumped amplifier, comprising:

a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, wherein the layers are epitaxial layers; and

an optical pump source coupled to the superlattice to optically excite gain within the superlattice.

112. (original) A bipolar transistor, comprising:

a collector including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion, wherein the superlattice has a miniband injector as an emitter region.

113. (original) A reconfigurable optical add drop multiplexer, comprising:

an optical demultiplexer that separates an input optical signal into discrete wavelengths that each propagating in its own waveguide;

an optical multiplexer;

a first plurality of waveguides that couple the demultiplexer and the multiplexer, each of a waveguide of the first plurality including a 1-to-2 optical switch, each switch including a silicon based superlattice with a plurality of layers that form a plurality of repeating units, at least one of the layers being an active region layer with at least one rare earth ion,

a second plurality of waveguides connected to the outputs of the 1-to-2 optical switches; and

electrical control circuitry configured to bias the superlattices and switch light into one of the first or second waveguides.